National Aeronautics and Space Administration
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CONSTELLATION X-RAY OBSERVATORY

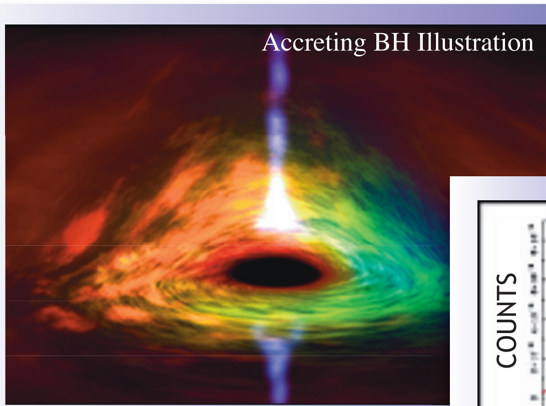
A Beyond Einstein Great Observatory

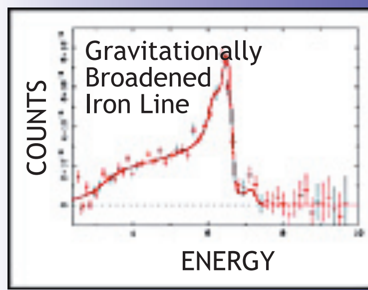
To Understand the Great Mysteries of Space, Time and Energy

BLACK HOLES

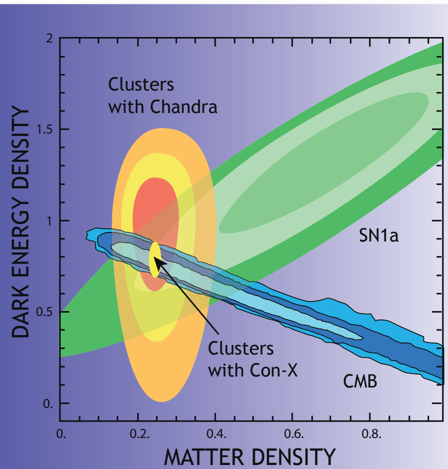
What happens to space, time, and matter at the edge of a black hole?

- Test limits of General Relativity in extreme gravity at black hole event horizon
- Measure spin of black holes
- Make first "movies" of matter spiraling into a black hole


Accreting BH Illustration



DARK ENERGY



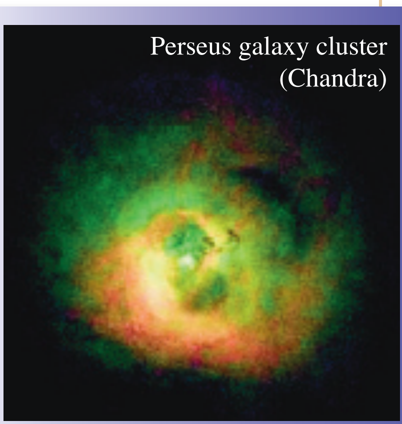
What is the Universe made of?

- Observe clusters and growth of structure to measure expansion of Universe and determine properties of Dark Energy (DE)
- Measure Dark Matter (DM) content of galaxies, groups, and clusters.
- X-ray observations of clusters see the 4% normal matter, and constrain the nature of the 26% DM and 70% DE.

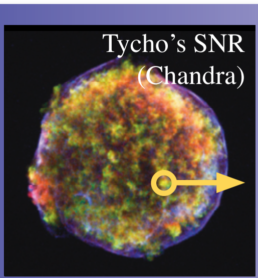
COSMIC FEEDBACK

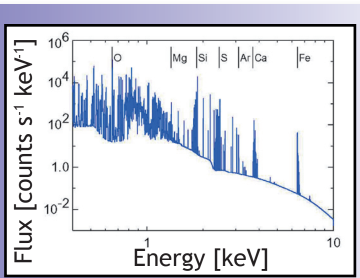
How did the Universe come to look like it does now?

- Understand connection between growth of supermassive black holes and host galaxies. Self-regulating accretion alternating with outflows from nuclear black holes?
- Study superwind feedback mechanism in starburst galaxies


Perseus galaxy cluster (Chandra)

LIFE CYCLES OF MATTER


Tycho's SNR (Chandra)



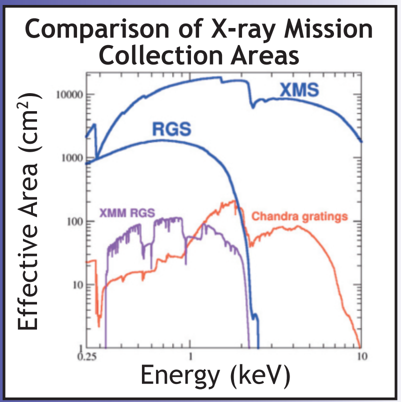
What is the origin of atoms in stars, planets, and living organisms?

- Trace formation of individual elements in SN explosions
- Probe formation of stars and planets
- Determine nature of superdense matter in neutron stars

The 2000 NRC Decadal Survey (Astronomy and Astrophysics in the New Millennium) ***ranked Con-X next in priority after JWST*** among major space-based initiatives. These Decadal Survey priorities were re-affirmed by a 2005 NRC Mid-Course Review. Con-X has also received strong endorsement from the Quarks to Cosmos NRC report.

http://constellation.gsfc.nasa.gov

Constellation-X: Mission and Technology



Con-X effective area vs energy compared to Chandra and XMM spectrometers. 100-fold increase in collecting area provides for breakthrough science.

MISSION OVERVIEW

- L2 orbit for high viewing efficiency and stable thermal environment
- 5 year lifetime with 10 year goal
- Technically ready, well understood, mission with simple spacecraft

KEY REQUIREMENTS

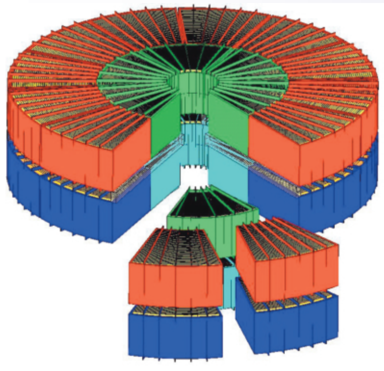
Bandpass: 0.25 to 40keV

Area: 15000cm^2@1.25keV, 6000cm^2@6 keV, 1500cm^2@40 keV

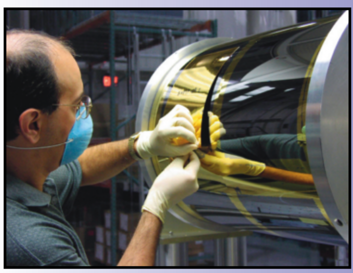
Spatial Resolution:
15″ HPD, 5″ goal, for SXT
1′ HPD, 30″ goal, for HXT

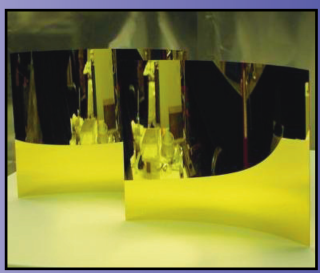
Spectral Revolving Power:
>300 from 0.25keV to 6keV
1500 from 6keV to 10keV

MIRRORS



- Spectroscopy X-ray Telescope (SXT) mirror technologies derive directly from flight programs (XMM-Newton, Suzaku) but with improved figure accuracy and reduced mass.
- Assembled from 60 (30) degree wedges into circular mirror. Reflection gratings behind SXT.
- Con-X uses thermally slumped glass coated with gold.
- Hard X-ray Telescope (HXT) mirrors use similar approach with multi-layer coatings to extend to higher energies.

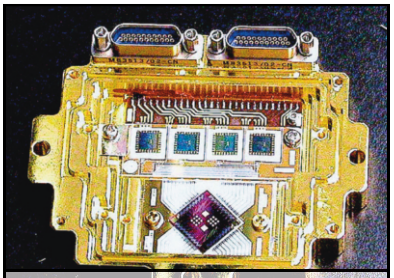




Left: A thermally formed glass segment being lifted off a mandrel.
Right: Two slumped glass segments coated with the gold reflective surface.

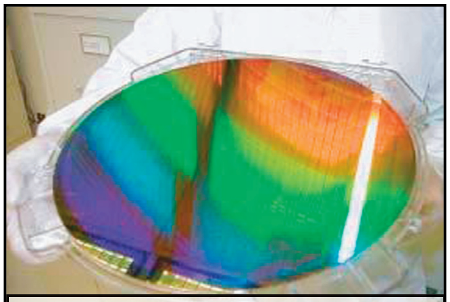
SCIENCE INSTRUMENTS

X-ray Microcalorimeter Spectrometer (XMS). Provides imaging, non-dispersive, high resolution spectroscopy at SXT focus. Superconducting device, closed loop cyro-cooler, no stored (expendable) cryogen.



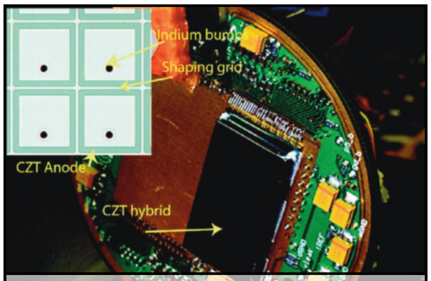
Prototype showing arrays of XMS chips & associated SQUID amplifiers

Reflection Grating Spectrometer (RGS). Provides high resolution, dispersive spectroscopy at lower energies. Attached directly behind part of SXT. Readout with CCDs



Prototype Reflection Grating in Lab

Hard X-ray Telescope (HXT) mirrors uses segments or full shells with multi-layer coatings to extend to higher energies. Provides imaging, moderate resolution spectroscopy at highest energies using hybrid CdZnTe arrays.



Prototype CdZnTe detector and readout electronics

X-ray spectroscopy now rivals the optical for breadth and depth of science. The technologies needed for Con-X are well understood and performance has been demonstrated.

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Smithsonian

Goddard Space Flight Center